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Impact of heavy fuel oil and natural gas prices on the value of biomass delivered to British Columbia pulp mills

G. Robinson

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by

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FOREWORD

ENFOR is the acronym for the Canadian Government's ENergy from the FORest (ENergie de la FORêt) program of research and development aimed at securing the knowledge and technical competence to facilitate in the medium to long term a greatly increased contribution from forest biomass to our nation's primary energy production. This program is part of a much larger federal government initiative to promote the development and use of renewable energy as a means of reducing dependence on petroleum and other non-renewable energy sources.

The Canadian Forestry Service (CFS) administers the ENFOR Biomass Production program component which deals with such forest-oriented subjects as inventory, harvesting technology, silviculture and environmental impacts. (The other component, Biomass Conversion, deals with the technology of converting biomass to energy or fuels, and is administered by the Renewable Energy Branch of the Department of Energy, Mines and Resources). Most Biomass Production projects, although developed by CFS scientists in the light of ENFOR program objectives, are carried out under contract by forestry consultants and research specialists. Contractors are selected in accordance with science procurement tendering procedures of the Department of Supply and Services. For further information on the ENFOR Biomass Production program, contact...

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ABSTRACT

The outlook for world oil prices to the year 2000 is for relatively modest real growth. This outlook has significant implications for the future price paths of heavy fuel oil used by B.C. coastal pulp mills, natural gas used by B.C. interior pulp mills, and the energy-equivalent value of wood waste in each region.

The long term price forecast of heavy fuel oil indicates very little real growth. As well as the world oil price outlook, the price forecast assumes a shrinking industry demand for this product. Given that the industry has already selected and implemented the most cost-effective energy conservation and fuel conversion measures, the modest increase in heavy fuel oil prices would imply that few additional "off-oil" investments would be justified. With regard to waste wood utilization, one would not expect a significant increase from present levels. That is, the rationale for investing in expanded wood waste utilization capability should be based on considerations other than a rapidly escalating heavy fuel oil price.

The price of natural gas to interior mills is forecast to escalate significantly from current levels. The forecaster assumes the implementation of the provincial government wholesale gas pricing policy according to the announced schedule. This schedule would move the provincial average wholesale price to 65% of the Vancouver refinery gate price by 1990. Price increases of this magnitude will encourage interior mills to switch away from natural gas by implementing energy conservation measures and substituting wood waste or coal.

RÉSUMÉ

D'ici l'an 2000, les prix mondiaux du pétrole devraient connaître une croissance réelle relativement modeste. Cette perspective a des répercussions significatives sur le comportement à venir des prix du mazout lourd utilisé par les usines de pâte de la côte de la Colombie-Britannique, sur ceux du gaz naturel utilisé par les usines de l'Intérieur et sur la valeur de l'équivalent en énergie des déchets ligneux dans chaque région.

A long terme, on prévoit unt très faible croissance réelle du prix du mazout lourd. Comme dans le cas du prix mondial du pétrole, cette prévision repose sur l'hypothèse d'une demande décroissante par l'industrie. Comme celle-ci a déjà retenu et mis en place les measures les plus rentables d'économie d'énergie et de remplacement des combustibles, une majoration modeste signifie que peu d'investissements supplémentaires visant à économie ser le pétrole seront indiqués. Pour ce qui est de l'utilisation des déchets ligneux, on ne doit pas s'attendre à une augmentation notable par rapport aux tonnages actuels, 'est-à-dire que les raisons d'investir dans l'utilisation accrue des déchets ligneux doivent se fonder sur autre chose qu'une flambée des prix due fuel lourd.

Le prix due gaz naturel payé par les usines de l'Intérieur devrait augmenter significativement par rapport à ce qu'il est actuellement. Cette prévision tient compte de la mise en vigueur de la politique provinciale de fixation des prix de gros du gaz selon le calendrier annoncé. Celui-ci prévoit de porter le prix moyen de gros dans la province à 65 % du prix à la sortie de la raffinerie de Vancouver, d'ici 1990. Des majorations de cet ordre inciteront les usines de l'Intérieur à abondonner le gaz naturel, à instituer des mesures d'économie de l'énergie et à le remplacer par les déchets ligneux ou le charbon.

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INTRODUCTION

The price of heavy fuel oil and natural gas is important to the forest industry in British Columbia. This industry accounts for approximately 80% of total industrial energy consumption (British Columbia, MEMPR 1981). The pulp and paper sector accounts for much of this. Although more than half of the energy is from self-generated sources (waste liquor and self-generated electricity) and wood waste, pulp mills are the largest industrial consumers of heavy fuel oil and natural gas. As a consequence, energy costs comprise a significant proportion of total production costs.

In 1976, energy costs accounted for about 7% of total production costs (British Columbia, MISBD 1980). The proportion may have increased since 1976 because of the significant real growth in oil and gas prices during the late 1970s. However, the forest industry, and the pulp mills in particular, have reduced fossil fuel consumption by implementing energy conservation measures and substituting wood waste for fossil fuels. Coastal pulp mills alone have invested more than $85 million over the past several years to increase biomass use. The industry effort has been assisted by the federal ENFOR and FIRE programs. British Columbia interior mills served by natural gas experienced a lower price increase. Consequently, the financial incentive to convert to wood waste was not as great. The role of fossil fuel prices in the wood biomass investment decision, as well as the opportunities and technical constraints, has been addressed elsewhere (McDaniels 1982).

This report presents up to date forecasts of crude oil, heavy fuel oil, and natural gas. The information presented here is relevant to energy and investment planning in the forest industry. The report could also assist analysis funded within the ENFOR program, since the price forecasts can be used to test the economic and financial viability of emerging technologies. Forest biomass is, in terms of its economic relationship with fossil fuels, a substitute. That is, a rising price of fossil fuels, all other things being equal, implies a greater demand for biomass. Hence the price forecast presented here can also be used to develop a demand forecast for biomass.

The price of domestic crude oil, heavy fuel oil and natural gas, is influenced by the international price of crude oil. In order to develop a price forecast for two fuels, a world oil price forecast must first be developed. Recent world oil price forecasts are therefore reviewed. These forecasts foresee a more stable long-term price trend than comparable forecasts prepared in the latter 1970s. Also, the relatively complex domestic oil price administration system is briefly reviewed. A blended oil price forecast is developed based on the world oil price forecast and consistent with the current energy pricing agreements. The British Columbia heavy fuel oil market is then reviewed to highlight recent market events and to identify long term market trends. Based on these considerations and the blended oil price forecast, the heavy fuel oil price relevant to B.C. coastal pulp mills is derived. A natural gas price forecast is presented. The forecast is based on the blended oil price forecast and incorporates the recent government pricing policy objectives [Govier, 1983]. Finally, the heavy fuel oil and natural gas price forecasts are translated into an energy equivalent value of biomass.

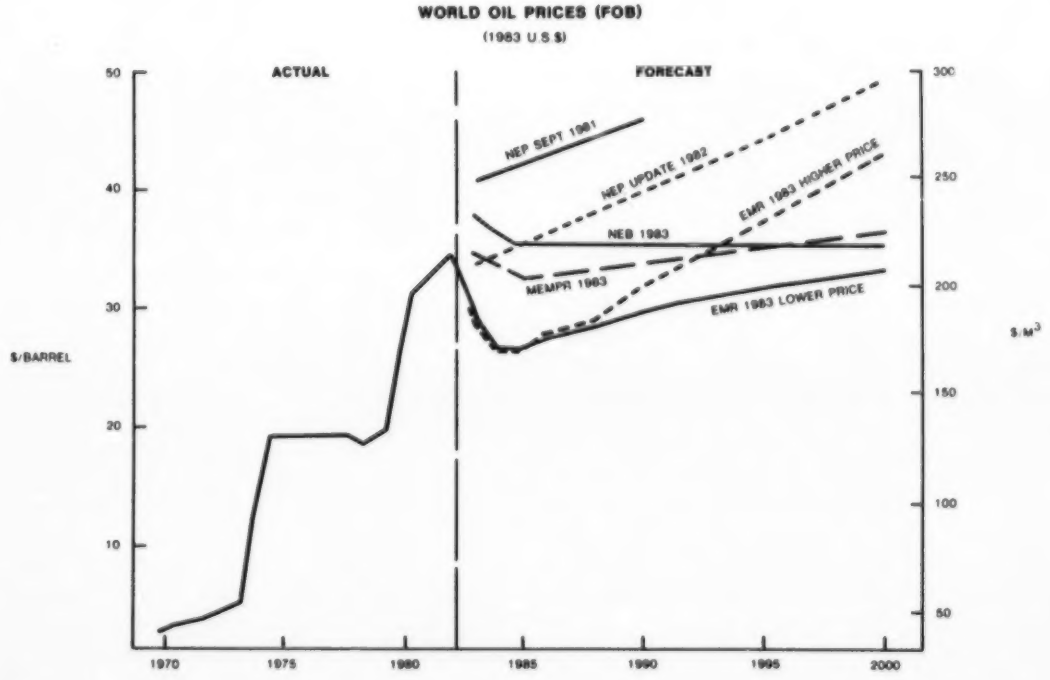
CRUDE OIL

The price of crude oil to domestic refiners is a weighted average of the prices for different categories of domestic oil, different qualities of imported oil and several federal taxes. This administered pricing system is intended to equalize the crude oil price throughout Canada before taking account of transportation differentials while at the same time providing an incentive to develop domestic supplies. This weighted average price, or the blended price, is thus dependent on the international price, as well as domestic policies. In this section, several world oil price forecasts are briefly reviewed to provide an overview of the recent trends in long-term oil price forecasts. With the recent decline in world prices, the present outlook is much different than it was only several years ago. After adopting a long-term outlook, the Canadian policies for establishing the domestic price are examined and a blended price forecast is developed.

World crude oil price forecast

Crude oil sells on the world market at any given time over a range of prices due to quality differentials as well as different contract provisions. The price differences due to quality differentials are, however, relatively static, hence the usual convention in forecasting the world oil price is to forecast the price of Saudi Arabia marker crude. From this, the price of other crudes can be approximated by assuming specific price differentials. Figure 1, the actual price of marker crude over the period 1970-1982 is presented before transportation costs (FOB Persian Gulf). Also presented in Figure 1 are several oil price forecasts prepared by Canadian agencies since 1980.

The forecast prepared in the summer of 1980, which was used for planning purposes in the Memorandum of Agreement (M.O.A.) between the Governments of Canada and Alberta is the most dated. It was prepared on the assumption



that oil prices would continue to escalate as they had throughout most of the 1970s. Subsequent to the M.O.A. forecast, the world oil price began to decline. The later forecasts reflect this price decline to varying degrees. The latest available price scenarios were those prepared by the Energy Strategy Branch of Energy, Mines and Resources (EMR) and indicate the sharpest price decline.

The common view among the later forecasts is that the world economy will continue to recover from the economic recession. With rising industrial output and incomes, energy demand will strengthen thereby halting the fall in oil prices. The forecasts indicate the real price[1] escalation will commence again after 1985. The real price escalation to the end of the period reflects the higher cost of alternative fuels and conservation, the higher cost of incremental sources of oil, and the continuing market power of OPEC.

For the purposes of this study we have adopted the lower and higher world oil price scenarios prepared by the Energy Strategy Branch, EMR (Energy Mines & Resources 1983). Figure One clearly reveals the large and rapid variation of actual oil prices and how quickly a long-term forecast can be in error. Hence a large band of uncertainty must surround any forecast of world oil prices. The EMR scenarios at least provide a reasonable range within which the price might vary.

In real terms, both oil price scenarios follow the same path to 1985. That is, the price falls in real terms from (US)$187.21/m³ to (US)$169.42/m³ in 1985 (FOB Persian Gulf). After 1985, given the lower price scenario, the world price escalates at a modest annual average rate of 1.33% to the year 2000. Over the same period, the higher price scenario exhibits a growth rate of nearly 3% per annum.

The lower and higher price scenarios are presented in Table 1. The prices for imported oil landed in Montreal include the transportation tariff from the Persian Gulf to Portland, Maine, the pipeline tariff between Portland and Montreal, and an adjustment for the average quality of crude imported into Canada.

Oil imported into Canada is, on average, of lower quality than Saudi marker crude. The appropriate quality price differentials have been taken into account to determine the prices presented in columns 4 and 5 of Table 1. On the other hand, domestic production is generally of superior quality to imported oil and, if selling on the world market, would command a higher price. Although domestic policies may establish the price of domestic oil below its appropriate value in world markets, it is nevertheless the corresponding world price that measures the resource's social value from the Canadian perspective. In column 6, the quality adjusted value of domestic oil corresponding to the world oil price forecast is presented. These latter values should be used for analytical purposes whenever a social economic analysis from the Canadian perspective is undertaken.

Blended oil price forecast

The price of crude oil to domestic refiners (and consequently consumers) is a weighted average price based on a schedule of wellhead crude oil prices established by the agreements between the Government of Canada and the producing provinces. Under this program, the blended price is currently less than the equivalent world price (after price adjustments for quality differentials) but it will slowly approach the world price over time.

There are essentially two categories of oil for the purpose of administering the wellhead price. The largest volume of domestic production is currently drawn from the category of oil labeled Conventional Old Oil. This is oil discovered before Nov. 10, 1973. These are light crude oils, low in sulphur content, easy flowing, and relatively easy to produce and refine. In 1980, the average wellhead price of this oil was $105.40 m³ ($16.75 /BBL) compared to a landed cost of imported oil of about $240/m³ ($38/BBL). The September 1, 1981 agreement between the Government of Canada and the Government of Alberta fixed a schedule of wellhead price increases covering the period 1981-86, subject to a cap of 75% of the international price. With the subsequent fall in the international price, the schedule was amended

[1] Real price in this study refer to the price of the commodity in constant 1983 U.S. dollars. The nominal price refers to the observed price which, after 1983, contains elements of inflation as well as real growth (or decline). See Appendix 1 for the study's price index forecast.

on June 30, 1983 for the period to December 1, 1984. The average wellhead price of conventional old oil is currently $187.22/m³ ($29.75/BBL).

The other category of oil is that qualifying for the New Oil Reference Price (NORP). This is oil derived from a variety of sources including synthetic oil production, oil from enhanced recovery, and new conventional oil from frontier and non-frontier basins. Oils in this category will earn the international price after adjusting for quality differentials. In the future, the proportion of domestic production from old conventional wells will decline and the proportion of NORP category oils will increase. Hence the weighted average domestic crude price will approach the international price of oil.

To arrive at the blended price, the federal petroleum compensation charge (PCC) and the Canadian ownership charge (COC) must be added to the wellhead price of conventional old oil. The PCC is a mechanism for raising the revenues required to pay the differential between the world and blended crude prices to domestic producers of NORP oil, and to compensate oil importers. In principle, the net balance in the fund should be zero as the PCC revenue collected on old oil offsets the revenue requirements of NORP and imports. Clearly the PCC will vary from year to year depending on the revenues required. The COC is a fixed charge established initially to finance the purchase of foreign firms, but now the revenue is considered part of the Government's general revenue account.

The Vancouver refinery gate price, or blended price, can be expressed as the sum of the average wellhead price of conventional old oil, the various federal taxes, and transportation charges from field to Vancouver. In December 1983, the Vancouver refinery gate total was $226.49/m³ (or $35.99/BBL) comprised of the following:

Average wellhead price	$187.22
PCC	23.66
COC	7.24
Gathering costs	3.21
Trans-Mountain Pipeline Tariff	5.16
	$226.49

(Source: Monthly Petroleum Review, Ministry of Energy, Mines and Petroleum Resources)

Assuming a continuation of existing policies, the future Canadian blended price will depend on wellhead prices, the proportion of domestic production from conventional old oil sources and from NORP sources, the work price of crude oil, taxes, and transportation costs. We have relied on the price, production and tax forecasts prepared by the Energy Strategy Branch[2]. To these forecasts are added a transportation cost forecast to yield the Vancouver refinery gate blended crude price forecast (Table 2).

Under the lower oil price scenario, the wellhead price is constant in 1984 at 1983 levels, than falls slightly in 1985. The decline in the wellhead price reflects the policy interpretation that following the expiration of the Amended Agreement, a wellhead price rollback is effected in order to restore the cap on old oil of 75% of the world price. In later periods, the wellhead price escalates due to a rising international price subject to the 75% cap policy constraint. The PCC escalates over the forecast period reflecting the growing proportion of domestic production earning the world price (synthetic levy, enhanced recovery levy, new conventional levy) and imports (import levy). In real terms, the refinery gate price of crude oil is projected to fall to $214.54/m³ in 1984 from a present level of about $225.60/m³. After 1985, the refinery gate price is forecast to rise at an annual average rate of 1.5%. As the proportion of domestic production earning the world price increases, the blended price will move toward the world price. After 1995, Vancouver refineries are forecast to pay 96% the world price for domestic oil.

The higher oil price scenario adopts an alternative policy assumption in which there is no rollback of the conventional old oil wellhead price in 1985. After 1986, the wellhead price escalates subject to the 75% cap as in the lower oil price scenario. Because of the alternative policy assumption, the refinery gate price is slightly higher in 1985. After 1985, the refinery gate price escalates at an average annual rate of 3% to 2000. Although at a higher price level, the blended price converges to world levels in a similar pat-

[2] Please note that we were advised by the Energy Strategy Branch that the lower and higher price scenarios are not official EMR forecasts. Further, the scenarios should not be viewed as necessarily representing the Department's most likely expectations about future policy settings.

tern as in the lower price scenario.

With the derivation of the Vancouver refinery price, we are now in the position to forecast the domestic heavy fuel oil price and the provincial natural gas price to industrial users.

HEAVY FUEL OIL

Heavy fuel oil is used by the ten coast pulp mills as a boiler fuel and in the lime kiln. Most of these mills have substantially increased their wood waste utilization in recent years, thereby reducing their reliance on heavy fuel oil. The particular mills are:

Mill Name	Company	Location
Tahsis	Tahsis	Gold River
Harmac	MacMillan-Bloedel	Nanaimo
Howe Sound Pulp Div.	Canfor	Port Mellon
Woodfibre	Western Forest Prod.	Woodfibre
Port Alice	Western Forest Prod.	Port Alice
Elk Falls	Crown Forest	Campbell R.
Crofton	B.C. Forest Prod.	Crofton
Port Alberni	MacMillan-Bloedel	Port Alberni
Powell River	MacMillan-Bloedel	Powell River

The price of heavy fuel oil (HFO) reflects the market balance between the opposing forces of supply and demand. In the B.C. market, product supply is influenced by local refinery production, the supply of HFO from extra-provincial sources, and government regulations. In general, an increase in the price of HFO will lead to an increased supply from local refineries and for extra provincial sources. Product demand in B.C., which is dominated by industrial consumers, is largely determined by the level of industrial output. A higher HFO price will lead over time to reduced consumption as energy conservation strategies are implemented and alternative fuels are substituted.

Government regulations also have a non-trivial effect on the market. Taxing and licencing regulations by the provincial and federal governments have altered the relative profitability of alternative HFO markets a well as restricted access to particular markets (i.e., the NEB currently regulates HFO exports). Other government programs have assisted industrial consumers reduce HFO consumption (the FIRE program for instance).

The future trend in the HFO price will depend on the interaction between market and supply and demand factors and the impact of government regulations. The interaction between these forces is complex and a full understanding of the market is beyond the scope of this study. Rather, we will briefly review the key elements of supply, demand, and government regulations as they are currently reflected in the market. Following this, those factors we reason might dominate during the forecast period are identified.

Heavy fuel oil supply considerations

A refinery produces a slate of products from the refining of crude oil. Heavy fuel oil is a lower valued product and is often considered an unavoidable by-product of the refining process. Generally, the pricing strategy followed by the refining industry is to recover as much of the crude cost, fixed cost, operating cost and profit margin on the lighter distillates (jet fuel, gasoline, light fuel oil and diesel). During periods of strong demand for the lighter products, the industry may be operating at capacity. Under these conditions HFO production may exceed market demand. The industry practice is generally to discount the price of HFO to stimulate demand and to serve as a loss leader for the sale of other products. Local refineries have, under these conditions, discounted the price of HFO to the pulp mills who purchase large volumes of other refined petroleum products as well.

During period of slack demand, the industry is unable to recover as much of their production costs on the lighter distillates and will attempt to recover a greater proportion on HFO. In general however, the industry is committed to reducing HFO yields to minimum levels since, over the long term, they expect to earn the highest return on lighter products. This reduction in HFO production can be effected by switching to lighter feedstocks (such as synthetic oil) and various in-plant changes. The latter option, which includes installing hydro-cracking or coking facilities, is reported to be too costly to be justified by the lower mainland refineries.

The supply of HFO to the B.C. market has historically come from refineries located in three areas:

— B.C./Lower Mainland

— inter-regional transfers from Alberta
— imports from California.

The supply of HFO in the lower mainland of British Columbia has fallen dramatically in recent years in response to falling demand. Part of the supply reduction has been borne by local refiners, but much of the reduction has been from extra-provincial sources. In 1983, imports and interprovincial transfers were negligible as HFO from these sources have found higher valued markets.

In the past, much of the HFO from Alberta was sold into the ship bunker market. However, the combination of easing of federal export restrictions which permitted access into the relatively high priced midwest market, and the imposition of a 20% advalorem provincial tax on bunker fuel, has made the ship bunker market relatively less attractive. For ships, relatively inexpensive HFO can be found in other west coast ports (or elsewhere). Consequently, most of the HFO that flowed west from Alberta into the bunker market presently flows into eastern markets.

Imports of HFO primarily served the coastal industrial market. Imports were particularly inexpensive in 1980 when the world oil price was nearly twice the domestic price. Import of HFO is treated, for government administration purposes, as if it was crude oil. That is, it qualifies for the Oil Import Compensation Charge plus a foreign exchange adjustment. The importer must pay the PCC and COC taxes, but these were much less than the rebate during 1980. If an importer could secure a sale of HFO substantially below the cost of crude oil, his net cost after compensation would be very low indeed.

Several elements have changed since 1980, and the import market does not presently offer an attractive buying opportunity. A major factor has been the decontrol of HFO exports in the U.S. (part of the larger oil decontrol policy) which has led to an HFO price nearly equal to the crude price. The higher price is generally attributed to Japan's participation in the spot market. This influence is expected to be relatively short term. That is, the price of HFO on the west coast is expected to decline as new sources of low cost HFO become available to Japan after 1985 (from new refineries in Indonesia and the Middle East). Another factor which serves to increase the HFO price to importers is that the import compensation payment is now much smaller. This is because the differential between the world and domestic crude prices is smaller. Although there is still some saving (primarily through the currency adjustment) it is nowhere near the magnitude observed in 1980.

Heavy fuel oil demand considerations

With respect to HFO demand, the largest users are the coastal pulp mills. A much smaller portion is sold to apartment blocks and commercial establishments. The cement factory located at Bamberton on Vancouver Island was a relatively large user, but the plant is now permanently closed.

The consumption of HFO in the Lower Mainland/Vancouver Island Region (which accounted for about 83% of provincial consumption in 1978) has declined sharply in recent years. This can be attributed primarily to the reduced requirements of the coastal pulp mills. This decline is apparent in the forecast of future HFO requirements for the Lower Mainland/Vancouver Island industrial sector presented in Table 3.

A pulp mill's HFO consumption will fluctuate over the short term in proportion to the plant's steam requirements which in turn are related to production levels. However the dramatic secular decline of HFO consumption reflects a long-term objective by the industry to minimize HFO consumption. Strategies for attaining this objective include various conservation measures, optimizing steam production and use, and switching to hog fuel. The latter strategy has had a substantial effect on reducing this sector's HFO requirements.

Since 1978 the four pulp mills located on Southern Vancouver Island and the mill at Powell River have in aggregate spent $85 million dollars to convert to hog fuel. To these mills, HFO is the highest cost fuel and it is the first to be reduced when steam requirements drop. In the summer, when steam requirements are relatively low, some of these mills meet their total steam requirements from self generated sources and hog fuel. In terms of total annual fuel use, in 1980 HFO met only 13% of the heat load at one plant to a high of 30% at another.

A portion of the forecast decline in HFO consumption is attributed to the switch to natural gas which was assumed in MEMPR's 1981 forecast to be available on the island by 1985. However, the sum of HFO and natural gas consumption is still less than total HFO consumption in the early years. This suggests the industry will continue to minimize fossil fuel consumption up to 2000. The mills will continue to require HFO for boiler start-up, particular applications not suited for natural gas, and as a stand-by fuel. But relative to past levels, the industry's HFO requirement will be quite small.

As noted earlier, the price of HFO reflects the balance of supply and demand factors acting on the market. From this brief review, it appears that over the long term HFO consumption will fall significantly. Refiners will respond by reducing HFO production where it is practical and economical to do so. Hence production and consumption are both anticipated to fall over time and the long term price trend will reflect the net effect. For example, if long-term supply were to decline more rapidly than demand, one might expect a relatively higher price trend as, at the margin, consumers are forced to higher cost sources of HFO (e.g., imported HFO or bidding HFO away from the eastern markets). In this case, the long-term price forecast would focus on the value of HFO in alternative markets. On the other hand, a sharp and lasting fall in demand relative to supply suggests that the future price trend would track a lower course correlated to refinery production costs. In our judgement, this latter course is the more likely case. Over the long term, HFO has generally been in excess supply on the west coast. We expect this trend to continue.

Heavy fuel oil price forecast

The general practice for forecasting the price of HFO is to fix its price as a percentage of the feedstock (crude oil) price. We agree that this approach has merit since crude oil represents the refiners largest production cost and we anticipate the future price trend to be more clearly related to production costs. The proportion varies among analysts. In recent submissions before the B.C. Utilities Commission regarding this issue the proportion varied between 70% and 85% of crude oil. Table 4 presents actual HFO and crude prices over a three-and-one-half-year period and the ratio of prices. Over the entire period, the simple average ratio was 75% (on a volumetric basis). However this ratio ranged from a high of 102% in early 1980 to a low of 59% in early 1983.

We were not satisfied with this approach for several reasons. First, a simple average (such as that computed in column 3, Table 4) does not demonstrate that a relationship does in fact exist between the price of crude oil and heavy fuel oil. Secondly, the monthly ratios show a distinct downward trend since 1980. During this period, the domestic crude price was escalating while the price of HFO grew more slowly. This suggests the HFO price is comprised of the crude price plus a relatively constant dollar margin.

Regression analysis was used to determine whether a statistical relationship could be supported by the data. The superior model was:

$$\text{Price}_{HFO} = 60.6027 + 0.407 \quad (V)$$
$$S = .05 \; R^2 = 68\%$$

where: V is Vancouver refinery gate price

This model was superior to the fixed proportion method and was used to forecast the HFO price presented in Table 5.

The price of HFO was forecast by substituting the price forecast presented in column 7, Table 2 for the refinery gate price. The HFO price corresponds to the plant gate HFO price, Vancouver. To this was added a constant transportation margin of $4.00 per cubic metre[3]. Also, the mills currently pay the 7% social services tax levied at the mill. The sum of the refinery gate price, transportation costs and taxes is the average cost landed at the mill site.

The influence of the world crude price forecast is clearly evident in the price pattern presented in Table 4. The HFO price for both scenarios declines in 1984 before beginning to escalate in 1985. The real cost escalation is a direct result of

[3] This is an estimated average transportation cost from lower mainland plants to coastal mills served by a medium sized barge. The $4.00/m³ charge is the approximate cost of serving the mills located at Harmac and Crofton. The transportation cost to the other mills would be slightly higher.

rising crude costs to Lower Mainland refineries. It should be noted however that the price of HFO does not move proportionately to the price of crude. A fall in the price of crude does not produce a proportional fall in the HFO price. Hence during the period of falling crude price the HFO/crude ratio rises (Column 3). Likewise, with a rising crude price the price of HFO escalates more slowly, consequently the price ratio falls. This is particularly pronounced for the higher price scenario.

Year	Percent of Vancouver refinery gate blended price
1983	41.80%
1984	45.11%
1985	48.43%
1986	51.74%
1987	55.06%
1988	58.37%
1989	61.69%
1990	65.00%

(SOURCE: A Report on the Marketing of British Columbia's Natural Gas, Decisions and Comments, Sept. 1983)

NATURAL GAS

Natural gas is consumed in eleven interior pulp mills served by three natural gas distribution utilities. The Inland Natural Gas Company serves the pulp mills located at Castlegar, Kamloops, Mackenzie, Prince George and Quesnel. The Pacific Northern Gas Company serves the mills located at Prince Rupert and Kitimat. The Columbia Natural Gas Company serve .he mill located at Skookumchuk. The pulp mills account for a large proportion of the natural gas distributed by these companies annually.

The price of natural gas sold in British Columbia is regulated by the provincial government. The provincial cabinet establishes the wholesale price of gas, or the price of gas to the distribution utilities. Upon receiving the natural gas from Westcoast Transmission Company Ltd., the distribution utility incurs a cost in transporting it to the final consumer. This additional cost is defined for the purposes of this study as the distribution margin. The value of the distribution margin is determined at rate hearings before the B.C. Utilities Commission. Hence the price of gas to the final consumer is the sum of the wholesale price of gas and the distribution margin appropriate to the particular customer category.

Recently, the British Columbia government adopted an explicit wholesale pricing policy and specific policy objectives (Govier 1983). The policy objective is to move the provincial average wholesale price of gas to 65% of the Vancouver refinery gate price of crude oil by 1990. In its decision, the government set forth a specific timetable for meeting this objective as follows:

In August 1983, the average wholesale price was increased to $2.22/GJ, or 38% of the refinery gate blended price. As of February 1, 1984, the average wholesale price increased to $2.36/GJ or 40%. The impact of these wholesale price increases was largely offset by reductions in the federal Natural Gas and Gas Liquids Tax (NGGLT) that occurred coincidentally. However, the NGGLT is now zero. Consequently, any future wholesale price increase should impact directly on retail prices.

The average wholesale price refers to the weighted average price of natural gas sold to the province's three major distribution utilities. The gas division of the B.C. Hydro and Power Authority serving the lower mainland takes the greatest volume of gas, or about 50% of total provincial consumption. The wholesale price paid by B.C. Hydro during the latter half of 1983 was $2.53/GJ. The Inland Natural Gas Company is the second largest utility, accounting for about 30% of the province's total consumption. It serves the central interior of the Province. The wholesale price paid by Inland during the latter half of 1983 was $2.16/GJ. Included in this total are sales to Columbia Natural Gas which purchases gas from Inland and serves the East Kootanay region (including Crestbrook Forest Products). Pacific Northern Gas Company Limited (PNG) serves the region west of Prince George to Prince Rupert and Kitimat. It accounts for about 12% of provincial consumption[4]. The wholesale price to

[4] The percentage of total gas consumption by each distribution utility does not sum to 100% because of gas consumed outside of the utility service areas (Fort St. John, Fort Nelson, Dawson Creek, Tumbler Ridge) and transmission fuel and losses.

PNG in the fall of 1983 was about $2.11/GJ.

The distribution utilities deliver gas to the respective pulp mills at what is referred to as schedule 11 and schedule 12 rates. The schedule 11 rate refers to firm gas sales while the schedule 12 refers to interruptable volumes. The schedule 12 rate is a slightly lower charge.

In the fall of 1983, the schedule 12 rates were: [5]

Inland	$2.89/GJ
Columbia	$0.1887/GJ and the cost of gas
PNG	$3.135/GJ

The distribution margin has been defined as the difference between the wholesale price and the retail price charged the particular rate category. For schedule 12 customers on the Inland and PNG systems in 1983 the distribution margin was $.73/GJ and $1.03/GJ respectively.

The forecast of the schedule 12 natural gas price was prepared in the following manner. The system average wholesale price of gas was first forecast by applying the schedule announced by the provincial government to the lower and higher Vancouver refinery gate price forecasts presented earlier (Table 2, Column 7). The resulting forecast of the average wholesale price of gas is presented in Table 6, column 2. The forecast of the utility specific wholesale prices consistent with the system average wholesale price is slightly more complex to determine, since it depends on the relative proportion of gas consumption developed by a recent government natural gas inquiry was adopted here as the best available information[6]. The schedule 12 rate was derived by adding the utilities respective 1983 distribution margin which was assumed to remain constant in real terms over the forecast period. Finally, the social service tax of 7% was added.

The forecast of natural gas prices relevant to the 11 pulp mills on the three gas distribution systems is presented in columns 3, 4 and 5. In real terms, the natural gas price escalates at an average annual rate of about 8% per year until the wholesale price reaches 65% of the Vancouver refinery gate price of oil in 1990, by which time, the price of natural gas will have escalated by nearly 60%.

Since imbedded in the wholesale price forecast is a relatively modest increase in the cost of oil, nearly all of the wholesale gas price escalation is attributable to the movement toward the 65% oil parity pricing objective.

Implications of the proposed Vancouver Island natural gas pipeline

In April 1983, the provincial government announced its decision to extend natural gas service to Vancouver Island (MEMPR 1983). The B.C. Utilities Commission conducted hearings in order to recommend the route and company to build the gas transmission segment of the line. The hearings were concluded and the recommendations filed with the provincial cabinet in 1984.

A major issue during Phase I of the hearings related to the heavy industrial market for natural gas. The pipeline could potentially serve four Island mills (located at Crofton, Harmac, Campbell River, Port Alberni) and Powell River. The pulp mills would consume a very large proportion of the pipeline's gas volumes in the initial years.

In order to consume natural gas, the mills would need to convert boilers to dual firing capability. An industry submission to the hearings indicated a total of twelve hog fuel boilers, four oil-fired boilers, one recovery boiler and nine lime kilns are potential conversion candidates (COFI 1983). The industry supports the concept of the project, however the decision to convert to natural gas will depend on the price of natural gas and the proportion of conversion costs born by the industry. It is generally agreed that in order to penetrate the market the price of natural gas must be less than the price of heavy fuel oil on any energy equivalent basis. There was some dispute regarding the size of the discount necessary. The industry submission indicated that a relatively large discount (e.g., 20%) would be required in the first two years to recover the conversion investment, followed by an on-going discount of 8% commencing in the third year. Other market studies assumed discounts ranging from 5% to

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[5] The schedule 12 rate on the B.C. Hydro System not presented because no pulp mill is served on this system.

[6] Govier 1982, Table 21-8, page 376.

10% were sufficient to secure the industrial market.

Assuming the project proceeds to construction, natural gas might be available on the Island by 1987. We have elected not to prepare a natural gas price forecast relevant to Vancouver Island mills because of the tentative nature of the information available at this time. Nevertheless, since the gas must be priced competitively with heavy fuel oil, a natural gas price forecast can be inferred from the HFO forecast presented in Table 5 by applying the appropriate discount.

CONCLUSIONS

The outlook for world oil prices to the year 2000 is for relatively modest real growth. In the short term, some erosion of the real oil price is expected, but the price is forecast to remain substantially above the level experienced prior to the market intervention of OPEC in the early 1970s.

The world oil price has a major influence over the prices for heavy fuel oil and natural gas sold in British Columbia. Its effect stems from the economic relationship of crude oil to refined products as well as explicit government energy pricing policies.

With respect to heavy fuel oil, the long-term price forecast indicates very modest growth. The forecast is premised on the outlook for crude oil prices and the shrinking market demand for heavy fuel oil. Given the lower oil price forecast, HFO prices are forecast to escalate at a modest average annual rate of 0.63%. For the higher price forecast the rate is 1.6%. This forecast is relevant to the 10 coastal pulp mills currently consuming heavy fuel oil.

The implications of this outlook on the industry's investment decision have not been addressed in detail here. However the following general conclusion can be drawn. Assuming that the industry has already selected and implemented the most financially attractive energy conservation and fuel conversion measures, the modest increase in HFO prices would imply that few additional investments would be justified. With regard to the future utilization of wood waste, one would not expect a significant increase from present levels. The rationale for investing in expanded wood waste utilization should be based on considerations other than a rapidly escalating heavy fuel oil price.

The price of natural gas to interior pulp mills is anticipated to escalate significantly from current levels. This outlook assumes the implementation of the provincial government wholesale pricing policy. The stated policy is to more the provincial average wholesale price to 65% of the refinery gate cost of crude oil (Govier 1983). Hence, in spite of the outlook for relatively stable oil prices, interior pulp mills are facing a major price escalation for natural gas. Given the lower oil price forecast, the average wholesale price of natural gas if forecast to escalate at an annual average rate of 7.5% to 1990, then 1.2% to the year 2000. The corresponding growth rates given the higher oil price forecast are 8.1% and 3.1% respectively.

Price increases of this magnitude will encourage strategies to reduce natural gas consumption such as conservation measures and switching fuels. The nature and magnitude of the potential response has not been addressed in this study. However, a recent industry survey estimated that mills on the Inland Natural Gas system would reduce natural gas requirements by 10.6 petajoules between 1984 and 1988 (COFI 1984)[7]. The same survey found that mills on the Pacific Northern Gas system would reduce gas consumption by 2.9 petajoules over the same period. The study stated that the industry would shift from natural gas to hog fuel and coal in response to the price increase.

The fossil fuel price forecasts have been expressed as energy equivalent value of wood waste in Table 7. The energy equivalent value of wood waste depends on the energy content of the wood and boiler efficiencies. Values that were thought to be representative of the industry were adopted in order to prepare Table 7. This table is intended to show the trend in the value of wood waste implied in the fossil fuel price forecasts. However, the values may vary widely among mills because of differences in parameter values and other

[7] The industry's forecast of natural gas prices was higher than the price forecast prepared here. The industry's forecast assumed some real price escalation of the distribution margin and was for schedule 12 rather than schedule 11 gas.

things (e.g., coastal mills purchase hog fuel in gravity packed units rather than the bone dry measure used here). The individual mill is encouraged to express the fossil fuel forecasts as the energy equivalent value of wood wastes appropriate to their particular conditions.

The value of wood waste corresponds to the delivered cost of an incremetal tonne (ovendried). The computation assumes that the capital investment required to utilize the wood waste has been fully amortized. For coastal mills currently on heavy fuel oil, the energy equivalent value of wood waste in the future is only slightly greater than the corresponding value today. Although not estimated for those coastal mills potentially served by the Vancouver Island gas pipeline, the implied wood waste price would be slightly lower, assuming natural gas would be priced at a discount to HFO.

For interior mills currently consuming natural gas, the energy equivalent value of wood waste in 1984 is substantially less than coastal mill values. By 1989, the energy equivalent value has increased for interior mills so that the value is about equal to the corresponding coastal value. After 1990 the value of wood waste to interior mills exceeds the coastal value. Between 1984 and 1995, the energy equivalent value of wood waste nearly doubles for interior mills. This trend is simply another illustration of the powerful economic incentive for interior mills to switch away from natural gas given the anticipated price rise of natural gas.

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APPENDIX I

Year	Consumer Price Index
1983	1.000
1984	1.045
1985	1.087
1986	1.130
1987	1.175
1988	1.222
1989	1.271
1990	1.322
1991	1.375
1992	1.430
1993	1.487
1994	1.547
1995	1.609
1996	1.673
1997	1.740
1998	1.809
1999	1.882
2000	1.957

APPENDIX II

TABLE OF VOLUME AND ENERGY CONVERSION FACTORS

Oil
$1 m^3 = 39.1492$ GJ
$1 m^3 = 6.292957$ BBL
1 barrel = 6.221209 GJ

Natural Gas: 1 MCF = 1.0967996 GJ @ 1040 MMBTU per MCF

Wood Waste:

Average coast: 21.0134 GJ/oven dried metric tonne

(assumes a mix of 57% whitewood, 35% cedar, 8% mixed wood)

Average Interior: 20.1 GJ/oven dried metric tonne

(assumes 100% Lodgepole pine)

Energy content of wood (MJ/Kg):

whitewood	19.8534
cedar	22.75
mixed wood	21.6804
Lodgepole pine	20.01

(SOURCE: Metric Conversion Factors for Forest products in Western Canada)

Table 1. Forecasts of basic Canadian oil prices (1983-2000) (in $/cubic metre)

1	2	3	4	5	6
	FOB Persian Gulf		Landed in Montreal		Domestic Production Landed in Montreal[2] Quality-Adjusted
Year	(1983 US$)	(Nominal US$)	(1983 CDN$)	(Nominal CDN$)	(1983 CDN$)
			Lower price scenario		
1983	187.21	187.21	230.69	230.69	249.24
1984	169.42	176.20	221.04	230.96	238.78
1985	169.42	183.25	220.95	240.18	238.72
1986	172.81	194.39	225.04	254.29	243.13
1987	176.27	206.21	229.16	269.26	247.58
1988	179.80	218.75	233.30	285.09	252.04
1989	183.39	232.04	237.49	301.85	256.57
1990	187.06	246.15	241.75	319.59	261.19
1995	196.60	314.76	252.62	406.46	272.93
2000	206.62	402.49	264.27	517.17	285.51
			Higher price scenario[1]		
1983	187.21	187.21	230.69	230.69	249.24
1984	169.42	176.20	221.01	230.96	238.78
1985	169.42	183.25	220.95	240.18	238.72
1986	174.68	196.49	227.25	256.79	245.51
1987	180.10	210.68	233.69	274.59	252.48
1988	185.68	225.90	240.28	293.62	259.59
1989	191.43	242.22	247.03	313.97	266.88
1990	197.36	259.72	253.96	335.73	274.37
1995	226.59	362.77	288.12	463.59	311.29
2000	260.14	506.72	327.64	641.19	353.98

[1] From "Long Term Supply/Demand Outlook" (draft), Energy Strategy Branch, Energy, Mines and Resources, July 1983.
[2] Quality adjusted using new oil reference price (NORP) differentials.

Table 2. Blended oil price forecast (Vancouver refinery gate) (CDN $/cubic metre)

1	2	3	4	5	6	7	8
Year	Old Oil[1] Wellhead	COC	PCC	Transportation[2],[4] Charge (from wellhead to Vancouver)	Blended Price (Vancouver)	Blended Price (Constant 1983 $)	Vancouver[3] Blended Price as a Percentage of World
				Lower price scenario			
1983	187.21	7.24	23.66	7.49	225.60	225.60	91
1984	187.21	7.24	22.09	7.65	224.19	214.54	90
1985	177.74	7.24	40.97	7.81	233.76	215.05	90
1986	189.19	7.24	43.25	7.97	247.65	219.16	90
1987	201.36	7.24	50.08	8.13	266.81	227.07	92
1988	213.73	7.24	53.91	8.29	283.17	231.73	92
1989	226.88	7.24	58.04	8.45	300.61	236.52	92
1990	240.83	7.24	62.49	8.62	319.17	241.43	92
1995	305.71	7.24	99.99	9.52	422.45	262.56	96
2000	387.36	7.24	123.44	10.51	528.55	270.08	96
				Higher price scenario			
1983	187.21	7.24	23.66	7.49	225.60	225.60	90
1984	187.21	7.24	22.09	7.56	224.19	214.54	90
1985	187.21	7.24	34.72	7.81	237.01	218.03	91
1986	191.26	7.24	43.82	7.97	250.29	221.50	90
1987	205.77	7.24	50.65	8.13	271.79	231.31	92
1988	220.00	7.24	55.30	8.29	290.83	237.99	92
1989	236.11	7.24	60.38	8.45	312.18	245.62	92
1990	253.37	7.24	65.92	8.62	335.14	253.51	92
1995	348.56	7.24	113.97	8.52	479.28	297.89	96
2000	480.38	7.24	168.51	10.51	666.64	340.64	96

[1] Columns 2 through 4 from EMR Long Term Energy Supply Demand Outlook, (Draft) July, 1983.

[2] Includes gathering costs and Trans Mountain Pipeline Ltd. tariff.

[3] Column 7 of this table divided by Column 6 of Table.

[4] Total transportation cost is less than reported in the text because an average gathering cost of $2.33/m³ is assumed rather than the $3.21/m³ recorded by MEMPR. The $2.33/m³ gathering charges is from EMR, and corresponds to the average gathering charge in mid-1983.

Table 3. Actual and forecast HFO consumption in the Lower Mainland/Vancouver Island Region industrial sector, 1978-1995 (in petajoules)

Year	HFO Consumption	Natural Gas (Vancouver Island Only)
1978 (actual)	33.799	n/a
1980	27.62	n/a
1985	12.88	7.83
1990	9.90	6.36
1995	9.68	6.08

(SOURCE: MEMPR, 1981)

Table 4. Domestic price of heavy fuel oil delivered at Harmac (excludes social services tax)

	1	2 HFO Price ($/barrel)	3 HFO as a percentage of Crude Price
1980	January	15.47	95
	February	16.47	102
	March	16.47	102
	April	14.17	87
	May	14.17	87
	June	12.50	76
	July	13.25	77
	August	15.25	80
	September	15.25	80
	October	15.33	80
	November	16.05	81
	December	16.05	81
1981	January	18.55	79
	February	19.55	83
	March	18.75	77
	April	18.75	77
	May	19.90	79
	June	22.25	80
	July	22.25	78
	August	22.25	78
	September	20.35	71
	October	20.35	65
	November	20.35	65
	December	21.00	72
1982	January	21.85	69
	February	21.85	69
	March	22.10	70
	April	22.10	70
	May	22.10	70
	June	22.10	70
	July	22.10	65
	August	22.85	67
	September	25.10	74
	October	23.50	69
	November	23.55	69
	December	23.55	69
1983	January	21.07	59
	February	21.07	59
	March	25.07	70
	April	26.01	73
	May	26.01	73
	June	26.01	73

SOURCE: MacMillan Bloedel Ltd.

Table 5. Heavy fuel oil price forecast (1983 $/cubic metre)

Year	HFO Plant Gate Price	Mill Gate Price	Mill Gate Price as a percentage of Blended Crude[1]
	Lower price scenario		
1983	152.45	167.41	74
1984	147.95	162.58	76
1985	148.16	162.81	75
1986	153.05	164.60	75
1987	154.95	168.04	74
1988	156.90	170.07	73
1989	158.90	172.16	72
1990	160.46	174.30	72
1995	167.46	174.30	70
2000	170.56	186.78	69
	Higher price scenario		
1983	152.45	167.41	74
1984	147.95	162.58	76
1985	149.37	164.10	76
1986	150.78	165.61	75
1987	154.78	169.89	73
1988	157.50	172.80	73
1989	160.60	176.12	72
1990	163.82	179.56	71
1995	181.88	183.50	67
2000	199.29	217.52	64

[1] Column 2, Table 4 divided by Column 7, Table 2.

Table 6. Forecast of average wholesale price of natural gas and schedule 12 retail prices by service area ($/Gigajoule)

1 Year	2 Average Wholesale ($/GJ)	3 Inland #12	4 Columbia #12	5 PNG #12
		Lower price scenario		
1984	2.39	3.13	3.59	3.39
1985	2.58	3.33	3.81	3.59
1986	2.81	3.57	4.07	3.83
1987	3.11	3.90	4.41	4.16
1988	3.37	4.17	4.71	4.43
1989	3.64	4.46	5.02	4.72
1990	3.92	4.77	5.35	5.03
1995	4.28	5.15	5.76	5.41
2000	4.42	5.30	5.92	5.56
		Higher price scenario		
1984	2.39	3.13	3.59	3.39
1985	2.61	3.35	3.83	3.62
1986	2.84	3.60	4.10	3.87
1987	3.17	3.95	4.47	4.22
1988	3.46	4.26	4.80	4.53
1989	3.78	4.60	5.17	4.87
1990	4.12	4.97	5.57	5.24
1995	4.87	5.77	6.43	6.04
2000	5.59	6.55	7.25	6.81

Table 7. Energy equivalent value of biomass implied in the fossil fuel price forecasts (delivered price, constant 1983 dollars/oven dried tonne)

Year	Coast		Interior	
	Lower price	Higher price	Lower price	Higher price
1984	57	57	44	44
1985	57	58	47	47
1986	58	58	50	50
1987	59	60	55	55
1988	60	61	58	60
1989	61	62	62	64
1990	61	63	67	70
1995	61	65	72	81
2000	66	77	74	92

Boiler efficiences:	wood waste	70%
	heavy fuel oil	85%
	natural gas	85%

See Table of volume and energy conversion factors in Appendix II for coefficients used for wood waste.